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Indian Standard

(Reaffirmed 1999)

METHOD FOR DETERMINATION OF DIMENSIONAL CHANGES ASSOCIATED WITH COMPACTING AND SINTERING OF METALLIC POWDERS (EXCLUDING POWDERS FOR HARDMETALS)

Powder Metallurgical Materials and Products Sectional Committee, SMDC 30 [Ref : Doc : SMDC 30 (2975)]

1. Scope

1.1 This standard specifies a method by which the dimensional changes associated with compacting and sintering of metallic powders are compared with those of a reference powder when processed under similar conditions (*see* **3**).

1.2 The method applies to the determination of three types of dimensional changes involved with the processing of metallic powders, excluding powders for hardmetals.

2. Principle

2.1 The test consists of compacting of a metallic powder or powder mix with admixed lubricant to produce a test piece of given density and then sintering it under controlled conditions. Measurement of dimensions of the unloaded die cavity, the green compact and the sintered test piece. Calculation of the algebraic difference between these various measurements as a percentage of the dimension of the die cavity or the green compact (*see* **8**).

2.2 Standard test pieces made from a reference powder are processed together with the sample under test and the dimensional changes of the two powders are reported.

3. Test Parameters

3.1 The reference powder shall be chosen by agreement between the supplier and the user and shall have a composition and properties as close as possible to those of the powder to be tested.

3.2 The following three types of dimensional change are dealt with in this standard.

3.2.1 *From die size to green size* (*spring back*) — The increase in dimensions of a compact, measured at right angles to the direction of pressing, after being ejected from the die.

3.2.2 *From green size to sintered size* (*sintered dimensional change*) — The change in dimensions of an object that occurs as a result of sintering.

3.2.3 *From die size to sintered size* (*total dimensional change*)

4. Symbol, Designation and Units — *See* Table 1.

TABLE 1 SYMBOL, DESIGNATION AND UNIT

Symbol	Designation	Unit
d_D	Test dimension of unloaded die	mm
d_G	Test dimension of green compact	mm
d_S	Test dimension of sintered compact	mm
Δd_{DG}	Spring back	percent (+)
Δd_{GS}	Sintered dimensional change	percent (+ or —)
Δd_{DS}	Total dimensional change	percent (+ or —)

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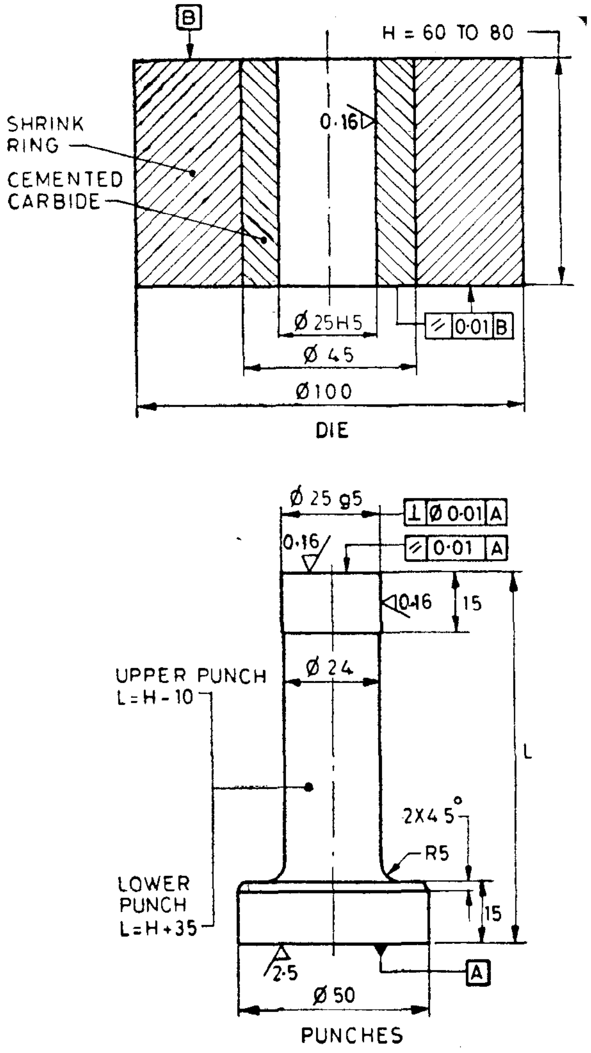
5. Apparatus

5.1 *Tool Set* — that will produce cylindrical test piece (*see* Fig. 1), rectangular test piece (*see* Fig. 2) or test pieces similar to the actual components.

5.2 *Press* — capable of applying the pressures necessary to achieve the required density.

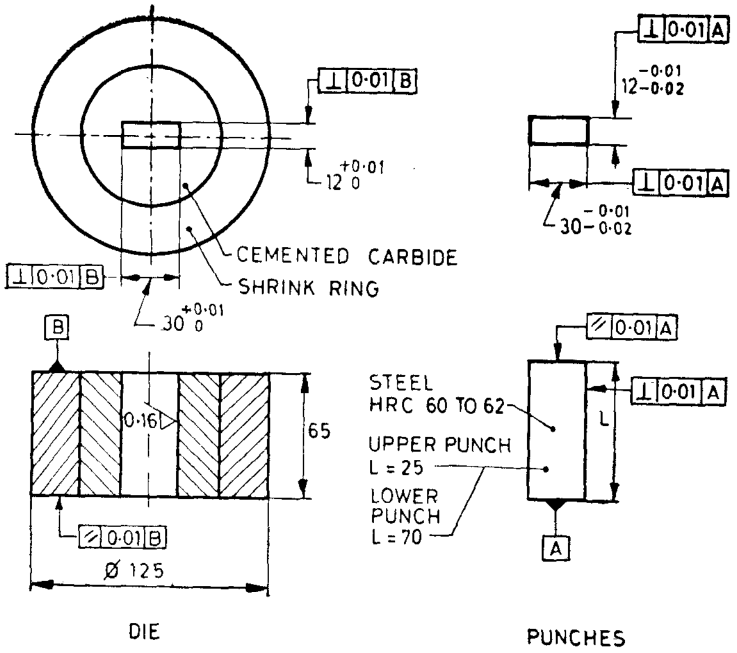
5.3 *Balance* — capable of weighing at least 100 g to an accuracy of ±0·01 g.

5.4 *Micrometer or Other Suitable Measuring Device* — for measuring the dimensions of the compacts and the die to an accuracy of ±0·005 mm.



All dimensions in millimetres.

FIG. 1 EXAMPLE OF TOOLING TO PRODUCE A CYLINDRICAL TEST PIECE



Note — Mating parts shall be fitted and lapped.

All dimensions in millimetres.

FIG. 2 EXAMPLE OF TOOLING TO PRODUCE A RECTANGULAR TEST PIECE

5.5 *Sintering Furnace* — capable of producing sintering conditions (time-temperature curve and atmosphere) as close as possible to those used in industry for the type of material to be tested.

6. Sampling — Representative quantities of both the test and the reference powders sufficient to give at least three compacts shall be taken.

7. Procedure

7.1 The test powder and the reference powder shall be mixed under the same conditions with the same mass of additives, including lubricant, to produce the composition of the sintered components for which the powder is required.

7.1.1 A test powder supplied ready for pressing shall be tested in the as-received condition.

7.1.2 To avoid the possibility of distortion during sintering, it is recommended that the test pieces should be not less than 5 mm thick.

7.2 Measure, to the nearest 0·005 mm, the test dimension (diameter or length) of the die in the unloaded condition and record the value, d_D, obtained.

7.3 Press at the agreed density at least three compacts from both the test and reference powders prepared as in **7.1**.

7.4 Measure, to the nearest 0·005 mm, the test dimension of the green compact and record the value d_G, obtained.

7.5 Sinter the test and reference compacts adjacent to each other under the conditions of time, temperature and atmosphere which stimulate production conditions to be used for the sintered components for which the test powder is required.

Note — The support for the test pieces to prevent distortion (that is, ceramic plate or furnace belt), the rate of heat-up, the atmosphere and the cooling rate may affect the dimensional change being measured, and should be consistent.

7.6 After cooling to room temperature, measure to the nearest 0·005 mm, the test dimension of the sintered test and reference compacts and record the value, d_S, obtained, ensuring that the dimensions before and after sintering are taken from the same position on the compacts.

8. Test Results

8.1 The dimensional changes, expressed as percentages, are given by the following formulae:

8.1.1 *Green dimensional change* (*spring back*) (*positive*)

$$\Delta d_{DG} = \frac{d_G - d_D}{d_D} \times 100$$

8.1.2 *Sintered dimensional change* (*positive or negative*)

$$\Delta d_{GS} = \frac{d_S - d_G}{d_G} \times 100$$

8.1.3 *Total dimensional change* (*positive or negative*)

$$\Delta d_{DS} = \frac{d_S - d_D}{d_D} \times 100$$

8.2 Report the dimensional changes for both the test and reference powders as the average of at least three determinations rounded to the nearest 0·01 percent.

9. Test Report — The test report shall include the following information:

a) Reference to this standard;

b) All details necessary for identification of the test sample;

c) All details necessary for indentification of the reference powder;

d) The type of test piece, and its dimensions before sintering;

e) The density of the green compact;

f) Sintering details;

g) The result obtained; and

h) Details of any occurrence which may have affected the result.

EXPLANATORY NOTE

In the preparation of this standard, assistance has been derived from ISO : 4492-1985 'Metallic powders, excluding powders for hardmetals — Determination of dimensional changes associated with compacting and sintering' issued by the International Organization for Standardization (ISO).

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